

A REVIEW OF THE BRITISH OPOMYZIDAE (DIPTERA)

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The acalyptrate family Opomyzidae has about 50 species in four genera worldwide, found mostly in the Holarctic. They are small, yellow to dark-brown flies with at least the apex of the wing clouded in most species and often with other wing spots. Vockeroth (1987) provides a full family description. The larvae feed within the stems of Gramineae and a few species are pests of cereals and rye-grass ley in Britain and other parts of Europe and in Russia (Balachowsky & Mesnil, 1935; Nye, 1958).

The Palaearctic catalogue (Soós, 1984) lists nine *Opomyza*, eighteen *Geomyza* and the single species in a third genus, *Anomalochaeta guttipennis* (Zett.). Since then, another nine *Geomyza* and one *Opomyza* have been described (Nartshuk 1984, 1992, 1993; Drake, 1992; Carles-Tolra, 1993). Most of these species were described or re-described by Czerny (1928) who also provided a nearly comprehensive key to the Palaearctic fauna. Collin (1945) provided a key to thirteen then known from Britain, and to these Andrewes (1964) added *G. angustipennis* Zett. and Drake (1992) described *G. subnigra*. Vockeroth (1961) pointed out the presence of two species under "*combinata*" of Collin (1945) and these are now known to be *balachowskyi* Mesnil and *hackmani* Nartshuk. Sixteen species are therefore included in the present paper.

Several papers have catalogued the opomyzids found in individual countries in Europe or Russia, sometimes including keys (e.g. Hackman, 1958; Trojan, 1962; Stackelberg, 1970; Martinek, 1978a; Greve, 1981; Nartshuk, 1993). These authors illustrated the genitalia of some species but a number remain unfigured. The chaetotaxy of both genera is remarkably uniform so that keys place strong emphasis on wing pattern and coloration but relatively little on morphology. However, the genitalia, especially those of *Geomyza*, are often distinctive, and their examination is sometimes essential for identification.

Existing keys, especially that of Collin (1945), have provided the main characters used in the following key which has been arranged so that, as far as possible, common species are placed towards the beginning within each genus. This paper uses the names as currently understood and does not constitute a taxonomic revision. Only a few type specimens have been seen and all the figures except one are of British specimens. McAlpine (1981) has been followed for morphological terminology; refer to Fig. 4d. Unpublished records on distribution and dates of capture have been collected by the author. Dimensions are given in Table 1.

KEY TO THE BRITISH SPECIES

- 1 Wing with well developed alula and small anal vein; basal and apical setae of the scutellum approximately equal in size; arista pubescent. Predominantly yellow or greyish yellow, medium to large (for the family) flies *Opomyza*, 2
- Wing without alula or anal vein; apical setae of the scutellum long, the basal pair very short; arista short plumose (in British species). Mostly small to medium-sized flies with moderately shiny black abdomens and black, reddish or yellow thoraxes *Geomyza*, 7
- 2 Costal margin darkened beyond vein R₁. Pleura with brown marks. Middle femora of males with dense posteroventral bristles (*germinationis* group) 3
- Costal margin clear except for apical spot. Pleura entirely yellow. Middle femora of males simple. (*florum* group) 4

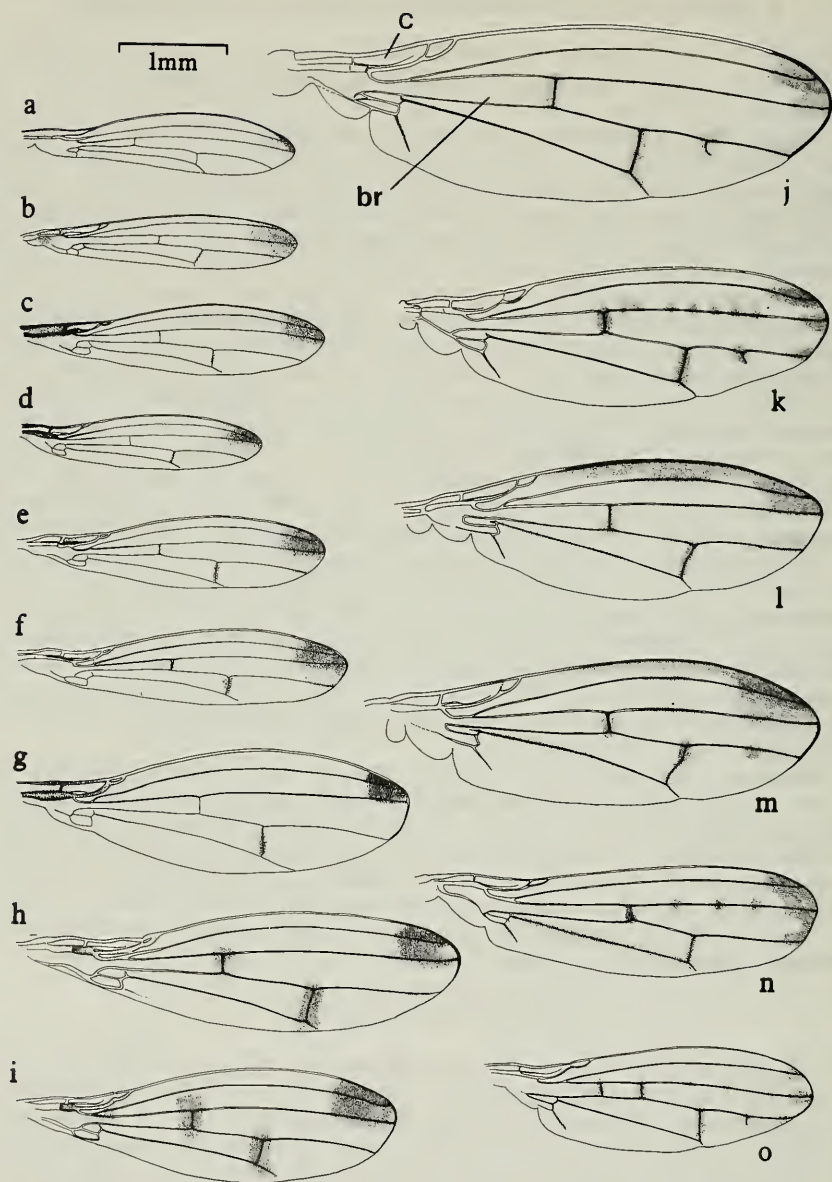


Fig. 1. Wings of British Opomyzidae. a: *Geomyza angustipennis*; b: *G. apicalis*; c: *G. subnigra*; d: *G. breviseta*; e: *G. balachowskyi*; f: *G. hackmani*; g: *G. venusta*; h: *G. majuscula*; i: *G. tripunctata*; j: *Opomyza florum*; k: *O. punctata*; l: *O. germinationis*; m: *O. petrei*; n: *O. lineatopunctata*; o: *O. punctella*. Names of cells: c—costal, br—basal radial.

- 3 Abdomen dark with rounded dull yellow patches at the sides of each tergite, often ill-defined. Proepisternum without setulae midway between the coxa and postpronotal lobe (do not confuse with setae on the anterior edge of these lobes, cf. Fig. 4g). Dorsal setae on last abdominal segment of the male short, weak and placed midway along the segment so that they do not extend beyond the segment; male cerci evenly curved in lateral view, ending in a flattened point, without tiny black spines (do not confuse with tips of the surstylar lobes) (Fig. 2a). Tip of ovipositor ends above the median line in lateral view, the upper and lower halves not being symmetrical images (Fig. 5b). *O. germinationis* (L.)
- Tergites yellow with dark central and lateral stripes, the central stripe never spreading sideways along the posterior margins of the tergites. Proepisternum with several setulae midway between the coxae and postpronotal lobe (Fig. 4g). Dorsal setae on the last tergite of the male long, placed near to its tip and extending well beyond the segment; cerci strongly angled in lateral view, ending in a blunt tip with numerous short black points (Fig. 2b). Upper and lower halves of the ovipositor are almost symmetrical images so that it appears rounded and blunt (Fig. 5c) *O. petrei* Mesnil
- 4 Wings with only four distinct dark marks comprising an apical spot, one on each crossvein and one midway along the last section of vein M (Fig. 1j). (The last section of vein R_{4+5} may be slightly clouded but this does not form a distinct spot) *O. florum* (F.)
- In addition to the four wing marks, there are distinct round spots either along the last section of vein R_{4+5} or in the basal radial cell before the r-m crossvein (Figs 1k, n, o) 5
- 5 Thorax with a dark central stripe. Vein CuA_1 and the adjacent membrane conspicuously dark (Fig. 1n) *O. lineatopunctata* von Roser
- Thorax without a dark central stripe. Membrane adjacent to vein CuA_1 virtually clear 6
- 6 Vein R_{4+5} without any spots or extra crossveins proximal to the r-m crossvein; apical spot continuous between the ends of the long veins, even if only faintly so (Fig. 1k). Prosternum (between the front coxae) with numerous setae. (Apart from extra spots on the last section of R_{4+5} this species resembles *florum*) *O. punctata* Haliday
- Vein R_{4+5} with clouds, with or without underlying extra crossveins, in the basal cell behind the first section of R_{4+5} ; apical spot comprising separate clouds on the ends of R_{2+3} and R_{4+5} (Fig. 1o). Prosternum with about three setae on either side *O. punctella* Fallén
- 7 Wing with large conspicuous dark spots on both crossveins (Figs 1h, i). Acrostichal setae in 6–8 rows at the level of the transverse suture 8
- Any shading on the crossveins is weak and restricted compared with the apical spot, and usually not extending appreciably beyond the long veins (Figs 1a–g). Acrostichal setae in 4, or sometimes 6, rows at the level of the suture 9
- 8 Anepimeron with one strong seta in addition to 1–2 weak setae (Fig. 4f). Wing usually with a distinct spot at its base, spreading from near the end of R_1 and covering the fork of R_{2+3} and R_{4+5} but if faint then at least the extreme base of R_{4+5} itself is darker at the fork than on most of its length (Fig. 1i). Surstylar lobes slender with a straight posterior margin in lateral view; cerci extend almost to the ends of the lobe (Fig. 4a). Sternite 8 of female terminalia entire (Fig. 5j) *G. tripunctata* Fallén
- Anepimeron with 3–5 setulae only (Fig. 4e). No discernible spot covering the tip of R_1 and the fork of R_{2+3} and R_{4+5} and the veins here not darker than on most of their length (Fig. 1h). Surstylar lobes large and broadly rounded with a curved

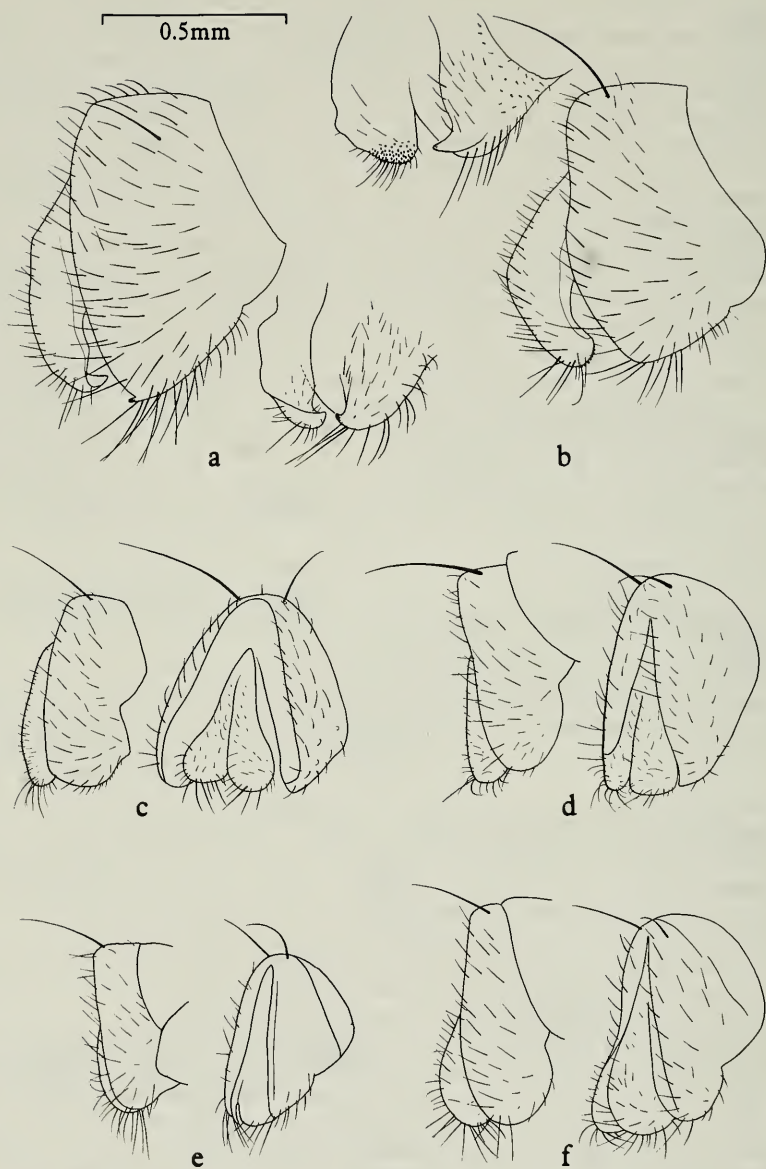


Fig. 2. Male genitalia of *Opomyza* species, lateral and posterolateral views (only the tips of the surstylar lobes are shown postero-laterally for a and b); a: *O. germinationis*; b: *O. petrei*; c: *O. florum*; d: *O. punctata*; e: *O. punctella*; f: *O. lineatopunctata*.

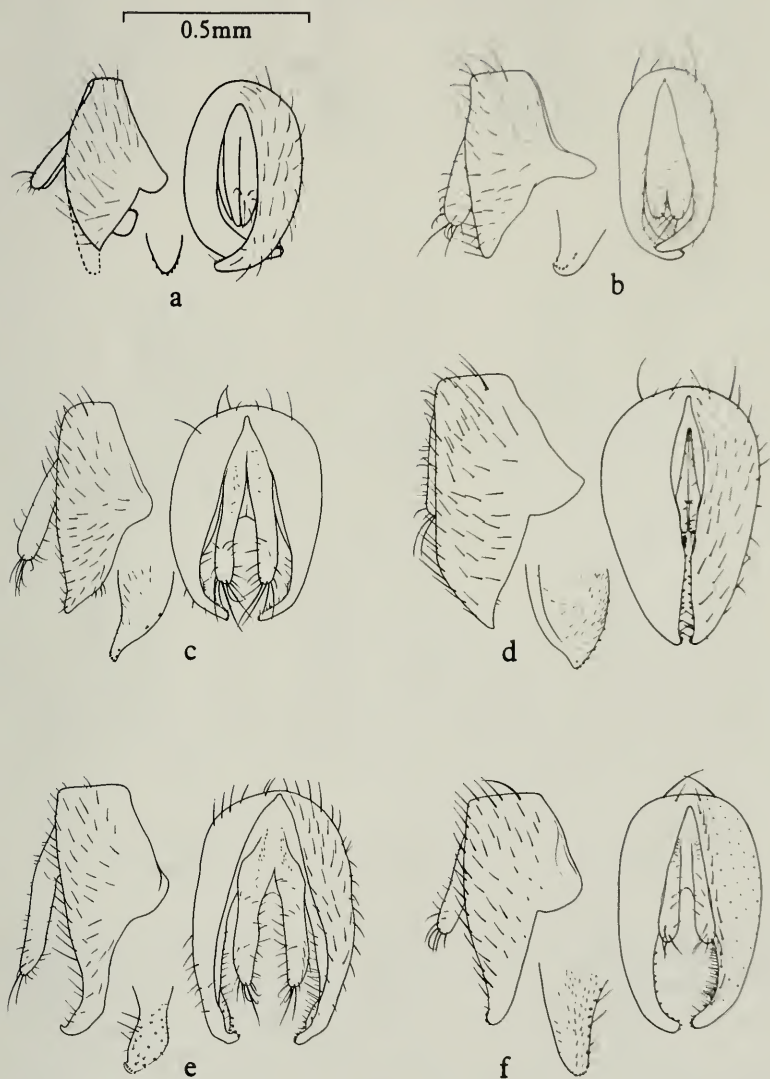


Fig. 3. Male genitalia of *Geomyza* species, lateral and posterior views and inner face of the tip of the surstylar lobe. a: *G. angustipennis*; b: *G. apicalis*; c: *G. balachowskyi*; d: *G. breviseta*; e: *G. hackmani*; f: *G. subnigra*.

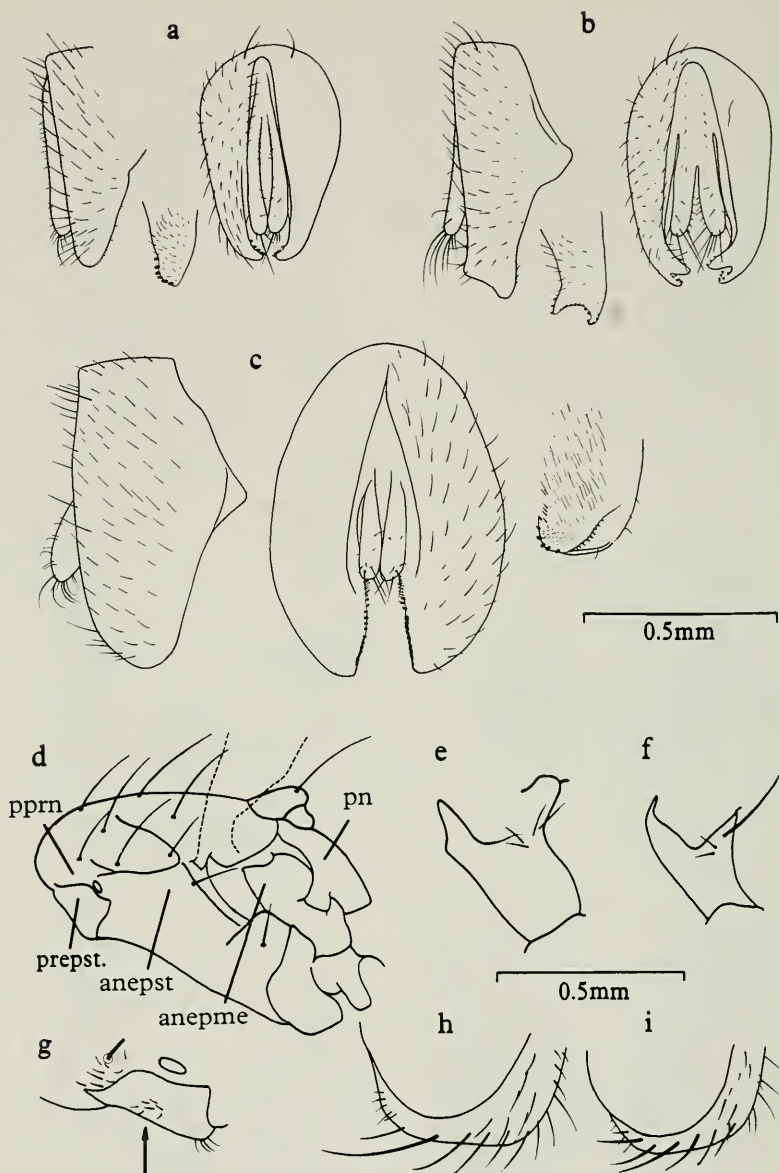


Fig. 4. (a-c) Male genitalia of *Geomyza* species. a: *G. tripunctata*; b: *G. venusta*; c: *G. majuscula*. d: Thorax of *Geomyza* showing location of proepisternum (prepst), anepimeron (anepme), postnotum (pn), anepisternum (anepst), postpronotal lobe (pprn). e: Anepimeron of *G. majuscula*. f: Anepimeron of *G. tripunctata*. g: Proepisternum of *Opomyza petrei*. h: Lower part of head of *G. apicalis* showing subvibrissal setae; i: the same for *G. subnigra*.

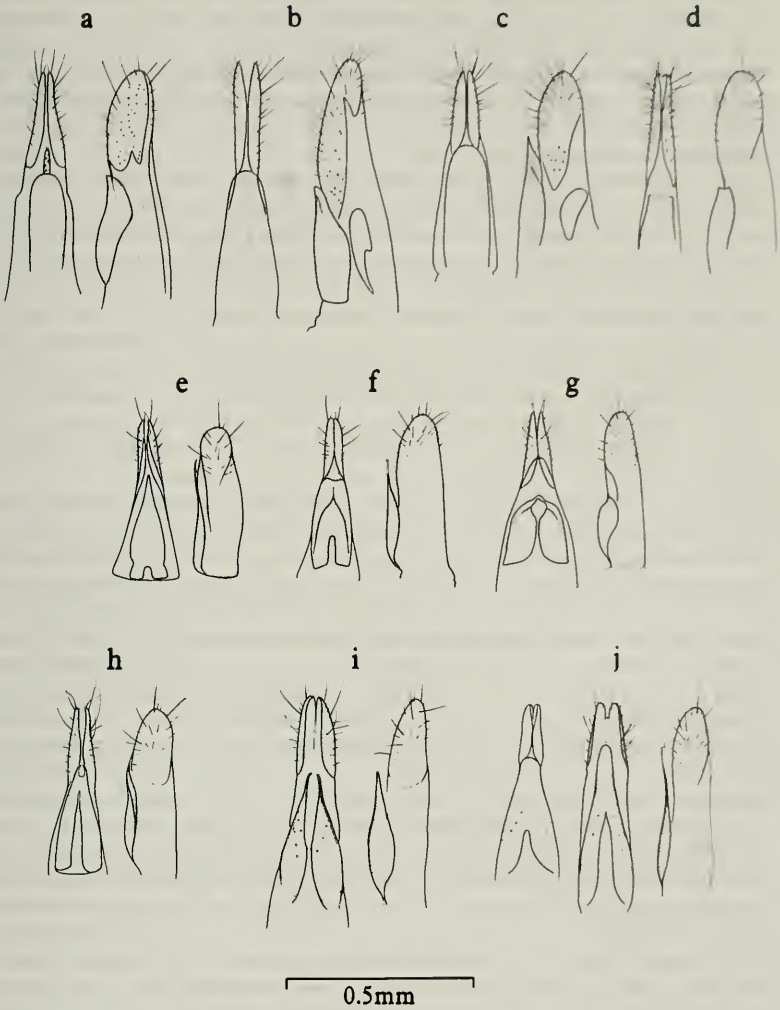


Fig. 5. Ovipositor of some *Opomyza* and *Geomyza* species, ventral and lateral views. a: *O. florum*; b: *O. germinationis*; c: *O. petrei*; d: *O. lineatopunctata*; e: *G. subnigra*; f: *G. breviseta*; g: *G. balachowskyi* (?); h: *G. venusta*; i: *G. majuscula*; j: *G. tripunctata*, showing two variations in ventral view.

- lower posterior margin in lateral view; cerci short, extending to about two thirds of the depth of the lobes (Fig. 4c). Sternite 8 of female terminalia divided medially (Fig. 5i) *G. majuscula* Loew
- 9 One pre- and three postsutural dorsocentral setae (the first postsutural may be small or absent in *apicalis* which keys out in both halves of this couplet). Thorax pale, yellow to orange 10
- One pre- and two post-sutural dorsocentral setae. Thorax pale or dark 13

- 10 Apical spot large and extending well behind vein M; wings narrow, their width 17–23% of their length (Fig. 1b). First postsutural dorsocentral seta about half or less the length of the presutural dorsocentral seta *G. apicalis* (Meigen)
 —Apical spot of the wing not extending behind vein M, or if so then only faintly; wings broader, their width very rarely less than 23% of their length measured to the root (Figs 1e–g). First postsutural dorsocentral seta not much smaller than the presutural dorsocentral seta 11
- 11 Surstylar lobes shallowly bifurcated at the tips (Fig. 4b). Thorax yellow, often with a distinct reddish tinge along the notopleura and top of each anepisternum, and usually with dark brown marks outside of the postsutural dorsocentral setae; postnotum dark. Crossvein r-m pale though may be surrounded by a faint cloud; length of the apical wing spot short, usually less than twice the length of the r-m crossvein; wings broader, their width about 28–33% of their length (Fig. 1g) *G. venusta* (Meigen)
 —Surstylar lobes of males with simple-ended tips. Thorax more or less uniformly yellow; postnotum pale or dark. Crossvein r-m dark and surrounded by a small dark cloud; length of the apical wing spot obviously twice or more the length of the r-m crossvein; wings narrower, their width usually about 23–28% of their length 12
- 12 Tips of the surstylar lobes terminate in an inwardly directed finger-like extension (it is essential to get a clear view of the tip) (Fig. 3c). Postnotum yellow, or at least more similar in colour to the rest of the thorax than to the abdomen. Females are not separable *G. balachowskyi* Mesnil
 —Tips of the surstylar lobes curved backwards with a slightly expanded rectangular end (Fig. 3e). Postnotum obviously darker than the rest of the thorax in all male specimens seen *G. hackmani* Nartshuk
- 13 Thorax dark brown. No subvibrissal seta is markedly stronger than any other (Fig. 4i) 14
 —Thorax orange or yellow. A strong subvibrissal seta may or may not be present (Fig. 4h) 15
- 14 Male surstylar lobes evenly tapered in side view and curve inwards at the tips in posterior view; cerci normal in size, clearly visible between the lobes and reaching well below the middle of them (Fig. 3f). Anterior part of thorax with very little pale or reddish colour, nearly all distinctly blackish-brown and lacking metallic reflections. Costal cell darkened. Sternite 8 of female terminalia tapered to a point (Fig. 5e) *G. subnigra* Drake
 —Lower part of the surstylar lobes evenly convex in posterior and lateral view, leaving a narrow more or less parallel gap between them; cerci very small, hardly reaching halfway down the lobes and scarcely projecting from between them (Fig. 3d). Anterior part of the thorax often distinctly chestnut-coloured with slight metallic reflections on the paler parts of the pleura. Costal cell almost clear. Sternite 8 of female terminalia truncate with a transparent semicircular extension (Fig. 5f) *G. breviseta* Czerny
- 15 No strong subvibrissal seta; all are weak (Fig. 4i) *G. angustipennis* Zetterstedt
 —One subvibrissal seta is stronger than the others (Fig. 4h) *G. apicalis* (Meigen) and *G. hendeli* Czerny

Opomyza florum (F., 1794). Only *O. punctata* can be confused with *florum*. It is one of the largest of the British opomyzids. Its thorax, and often the abdomen, is entirely yellow although there are often small brown lateral spots on the abdomen

which may darken in dried specimens. The last section of vein R_{4+5} may be infuscated and this must not be confused with the separate spots of *punctata*. The species typifies the group of closely related species which have very similar genitalia in both sexes and the males of which have middle tibiae with simple chaetotaxy.

It is widespread in Britain and sometimes common in lowland areas but scarce in western pastureland. It is a serious pest of wheat, barley and *Lolium* in Europe and Russia (e.g. Slope, 1957) but the wild hosts are not known. Thomas (1933) describes the life history. There is one generation per year. The eggs are laid on the soil close to the base of a wheat stem in autumn and probably overwinter in this stage, unlike nearly all other opomyzids studied which overwinter as third instar larvae. The eggs hatch in spring, the larvae pupariate within the tillers in May and the first adults emerge in early June. They are long-lived and move away from the fields into woodland and hedgerows until October when they mate and return to lay their eggs in arable fields. This account agrees with the dates of records which extend from the beginning of June to early November with most occurring from August to mid-October.

Opomyza germinationis (L., 1758). There is a strong possibility that some of the specimens in the Linnaean collection were muddled at some time because there is a specimen of what we know as *O. germinationis* masquerading as the type specimen of *Geomyza combinata* and the type specimen of *germinationis* is a species of *Palloptera* (Brian Cogan, pers. comm.). Linnaeus's description of *Musca germinationis* fits the species now known by this name rather better than the *Palloptera* or those in the *combinata* group. Although *germinationis* is the type species of the genus *Opomyza* Fallén, it would be prudent to retain the name *Opomyza* in the currently accepted sense rather than attempt to redefine the genera *Opomyza* and *Geomyza* on the basis of the Linnaean types.

The characters used in couplet 2, together with the form of the genitalia, separate *germinationis* and *petrei* into a group that is clearly different from the remaining, predominantly yellow, British *Opomyza*. The abdominal pattern of occasional specimens of *germinationis* may resemble that of *petrei* but then the central stripe extends at least partly along the hind margins of the tergites, thus breaking up its outline. In doubtful cases, the other key characters will separate them. Of many hundreds of specimens examined, only one *germinationis* had several distinct proepisternal setulae. A similar *Opomyza* from eastern Europe and Russia is *thammeri* Strobl which differs from *germinationis* (and *petrei*) in having a completely shining black abdomen and the costal shading starting beyond the level of crossvein r-m. Two Macquart species, *fuscipennis* and *fasciata*, may be synonymous with *germinationis* as they are not mentioned in Soós (1984) and no-one but Czerny (1928) and Séguy (1934), neither of whom had evidently seen these species, makes reference to them.

Opomyza germinationis is probably one of the commonest British flies, being found in a wide range of habitats throughout the country including Orkney. It is univoltine, the eggs being laid usually near the base of the stems of host plants or on the soil in early September to early November, the larvae overwintering mostly in the third instar, pupating in May and emerging in June (Thomas, 1934). The larvae feed within the stems of many species of common grasses (Thomas, 1934; Nye, 1958).

Opomyza lineatopunctata von Roser, 1840. This unmistakeable small yellow fly is the only one in the *florum* group with a thoracic stripe. Rarely, there are extra small spots, with or without underlying crossveins, proximal to crossvein r-m, as in *punctella*.

The ovipositor differs from those of the other British *Opomyza* in sternite 8 being truncate and slightly indented (Fig. 5d). Two other European species also have a dark central stripe on the thorax: *nigriventris* Loew has an almost black, shiny abdomen and is not known from western Europe, and *decora* Oldenberg, known only from Italy, lacks the spots on the distal section of vein R_{4+5} and cell r_{4+5} is somewhat darkened.

There are records from Kent, Sussex, Surrey (Allen, 1965), Berkshire, Somerset (Drake & Godfrey, 1989), Cambridgeshire, Suffolk, Norfolk, Salop, Cheshire, S. Yorkshire, Lancashire, Cumbria, Argyll, and all Welsh counties. The majority of the records come from bogs, heaths and fens. Although the fly has not been reared, there is strong circumstantial evidence that the host plant is *Molinia caerulea* (L.) Moench as this was the dominant grass at many of the localities. In Czechoslovakia, Martinek (1978a) has also swept it from pure stands of *Molinia* on wet ground in partial shade but not in dry areas away from the woodland. Despite the widespread occurrence of *Molinia*, *O. lineatopunctata* can be very locally distributed within apparently suitable areas. Falk (1991) lists it as nationally scarce although it probably does not warrant this status. The dates of capture range from late June to November with the majority in mid July to early August, though the fly was frequent in October in Welsh wetlands.

Opomyza petrei Mesnil, 1934. This species is probably overlooked because of its resemblance to the ubiquitous *germinationis*. In the field, its brighter colour helps to distinguish it from that species but some specimens are dark and have only a very vaguely differentiated central abdominal stripe so the other key characters need to be checked.

Opomyza petrei is a widespread species found in most parts of Britain, including Orkney, though Soós (1984) does not mention its presence here. No habitat preferences are apparent in the records. The larvae have been found in tillers of *Holcus lanatus* L., *Anthoxanthum odoratum* L. and *Agrostis tenuis* Sibth., and would seem to show a markedly different host plant preference to that of *O. germinationis* (Mesnil, 1934, Nye, 1958, 1959).

Opomyza punctata Haliday, 1833. Several authors have commented on the unsatisfactory separation of this species from *florum* (Collin, 1945; Hackman, 1958; Greve, 1981). It differs from *florum* in having 1–6 spots on the last section of vein R_{4+5} and, in my sample of eight females and six males, having significantly ($P < 0.05$) smaller mean wing and thorax lengths with almost no overlap in size (Table 1). I have dissected and compared the male genitalia of both species but could find no differences in any external or internal components. The internal structures of *lineatopunctata*, *germinationis* and *petrei* are, by contrast, markedly different from this pair of species. The two species are provisionally kept separate in this work.

Opomyza punctata has been recorded from Kent (Parmenter, 1960; Allen, 1965), Essex, Suffolk, Norfolk, Lincolnshire, Hereford, Leicestershire, South and North Yorkshire, Durham, Cumbria, Northumberland and County Down, Ireland (type specimen). The only reference to the biology of the species is given by Allen (1965) who recorded it in areas dominated by *Dactylis glomerata* L. in his garden. It has twice been caught in *Arrhenatherum*-dominated sward on coastal dunes. The dates of capture range from July to early September so it is likely to be univoltine. It is classified as nationally scarce (Falk, 1991).

Opomyza punctella Fallén, 1820. This is a small, entirely yellow species. The extra crossveins and spots separate it from other British species except *lineatopunctata*

Table 1. Lengths of the wing, thorax (measured from its front end to the tip of the postnotum), and total body (mm). The wing and thorax were measured to the nearest 0.05 mm and the range quoted to the nearest 0.1 mm, and the total length to the nearest 0.25 mm. The dimensions were measured on at least ten specimens of each sex of the frequently occurring species

	Wing		Thorax		Total body	
	Female	Male	Female	Male	Female	Male
<i>O. florum</i>	4.4–5.1	3.8–4.4	1.9–2.1	1.5–1.9	4.5–5.75	3.75–4.5
<i>O. germinationis</i>	3.6–4.1	3.5–3.8	1.6–1.9	1.6–1.8	4.25–5.0	3.75–4.75
<i>O. lineatopunctata</i>	2.8–3.8	2.7–3.5	1.2–1.5	1.0–1.4	3.25–4.25	2.75–3.75
<i>O. petrei</i>	3.9–4.3	3.8–4.3	1.8–2.0	1.7–1.8	4.25–5.0	4.0–4.75
<i>O. punctata</i>	3.4–4.3	3.2–3.9	1.5–1.8	1.3–1.6	3.75–5.0	3.25–4.0
<i>O. punctella</i>	3.0	2.9	1.3	1.2	3.3	3.15
<i>G. angustipennis</i>	2.8	2.8	1.0	1.15	—	2.9
<i>G. apicalis</i>	2.1–2.4	1.9–2.7	0.9–1.5	0.9–1.1	2.75	2.3
<i>G. balachowskyi</i>	—	2.6–3.1	—	1.1–1.5	—	3.0–3.75
<i>G. breviseta</i>	2.3–2.7	2.4–2.6	1.1–1.4	0.9–1.2	2.75–3.25	2.5–3.0
<i>G. hackmani</i>	—	2.8–3.2	—	1.3–1.5	—	3.25–3.75
<i>G. hendeli</i> ?	2.4	—	1.1–1.2	—	3.0	—
<i>G. majuscula</i>	3.0–3.8	3.5	1.7–1.9	1.8	4.25	4.25
<i>G. subnigra</i>	2.3–2.7	2.2–2.7	1.1–1.4	0.9–1.3	2.75–3.75	2.5–3.25
<i>G. tripunctata</i>	2.6–3.4	2.7–3.4	1.1–1.5	1.0–1.4	3.25–3.75	2.5–3.75
<i>G. venusta</i>	3.3–3.7	3.2–3.6	1.4–1.8	1.4–1.7	3.25–4.0	3.5–4.0

which very occasionally also has extra veins and spots before the r-m crossvein but is distinguished by having a dorsal thoracic stripe.

Opomyza punctella would appear to be a species of cooler climates. Most records come from northern European countries. Although it is probably rare throughout most of its range, Hackman (1958) listed many localities for it in Finland and implied that it was frequent there. In central Europe, it is confined to mountainous areas and all Martinek's (1978a) Czechoslovakian records came from localities over 1000 m. The British distribution fits a similar pattern, with all records coming from Scotland (Grampian, Strathclyde) and northern England (South Yorkshire, Durham, Northumberland), though one is from coastal dunes. Its host plant is not known. Apart from one record in early September, all dates of capture are in July. The species is classified as vulnerable in Shirt (1987) and down-rated to rare by Falk (1991).

Geomyza angustipennis Zett., 1847. Both crossveins and the adjacent membrane are completely pale, making this small species distinctive. The first two tergites and bases of the others are orange. Gibbs (1989) gives a full description of the female. I have seen only two specimens and one of these is from Yugoslavia so the range of variation is not known. The drawing of the male genitalia (Fig. 3a) is of the Yugoslavian specimen in the Natural History Museum, London. Two other European species, *G. adusta* Loew and *G. denigrata* Czerny, may key out at the same couplet as *angustipennis* but both have dark thoraxes and only vaguely darkened wing tips so look superficially more like *G. breviseta* or *G. subnigra*.

The only known records are from the edge of a cornfield at Soakham, Kent (Andrewes, 1964), Lady Park Wood (deciduous), Gwent (Gibbs, 1989), and an unconfirmed record from Speybridge, Highland (Gibbs, 1989). It is classified as endangered in Shirt (1987) and downgraded to rare by Falk (1991).

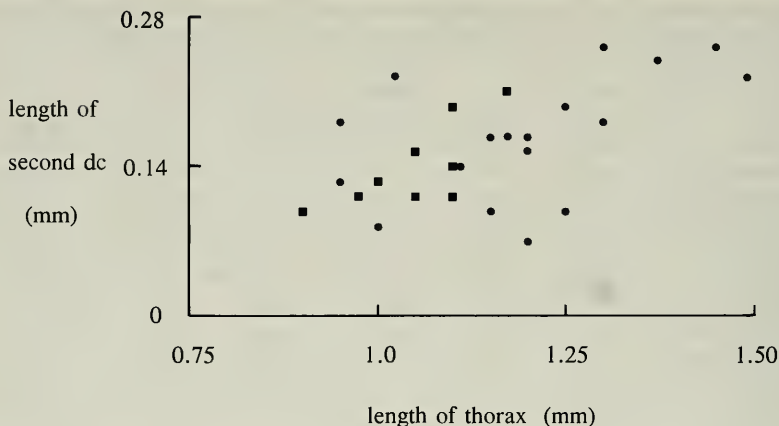


Fig. 6. Length of second dorsocentral seta (first postsutural) against thorax length for *Geomyza apicalis*. Circles = females; squares = males.

Geomyza apicalis (Meigen, 1830). The large apical wing spot, narrow wings and clear r-m crossvein make this species moderately easy to identify but the variable size, or even absence, of the first postsutural dorsocentral seta could lead this species to key out as *hendeli* in the keys of Collin and Czerny. However, there are good grounds for thinking that *hendeli* is merely a small form of *apicalis*. Measurements of the first three dorsocentral setae of 27 specimens of two series of *apicalis*, from Egham, Surrey, in the Natural History Museum, and from Blakeney, Norfolk, in the Castle Museum, Norwich, and single specimens from three other localities, show that the second (first postsutural) seta is shorter in smaller specimens (Fig. 6), although there is still considerable variation in its length. As a proportion of the length of the third (second postsutural) seta, the second seta varies from 24 to 80%, compared to the nearby acrostichal setae whose lengths are 17–30% of that of the third dorsocentral. The second dorsocentral of the smallest male in the Egham series could have easily been overlooked, being only one-third as long again as the acrostichals. Further comments are made under *hendeli*. The wing breadth as a percentage of its length is 20.5% (range 17.1–22.8%) for both female and male.

Two more European species would key out at couplet 15 in the key. *Geomyza pilosula* Czerny looks more like *G. balachowskyi* and has only pilose aristaes. *Geomyza virgata* Czerny has only three dorsocentral setae but otherwise would appear to be very similar although Czerny described the male genitalia as smaller than usual. A male from Germany labelled *virgata* in the Natural History Museum looks like *G. apicalis* and its genitalia are of the *apicalis* type.

Geomyza apicalis has been recorded from Kent (Allen, 1982), London (Natural History Museum, as *hendeli*), Hertfordshire (Natural History Museum, in Collin (1945) as *hendeli*), Surrey, Essex (Collin, 1945), Cambridgeshire, Norfolk, Humberside, Derbyshire (Kidd, 1954), South, West and North Yorkshire (Skidmore *et al.*, 1985; Vockeroth, 1961) and Northumberland. The habitats where *G. apicalis* has been found include grazing marsh, a moist shaded clay slope with *Equisetum* and sparse grass, mud under reeds by an estuary, dunes and a sewage farm. Martinek (1978a, quoting

Karl, 1930) described it as a xerophile found on coastal dunes and in dry pasture, and Vockeroth (1961) stated that it occurs on dry ground. Not all the English localities conform with this preference for dry habitats. It is classified as nationally scarce (Falk, 1991).

Geomyza balachowskyi Mesnil, 1934. There are several species in the *combinata* group but only this species and *hackmani* have been recognized in Britain. These two can be separated reliably only on the basis of the male genitalia which need to be exerted so that the surstylar lobes are clearly visible. It is easy to mistake an incompletely visible twisted lobe of *balachowskyi* for that of *hackmani*. There seem to be no differences between the ovipositors of females caught in the same areas as males of the two species. The colour of the postnotum is the same as, or only slightly darker than, the rest of the thoracic dorsum. The wing width is 24–28% of its length. Two males and a presumed female from St Kilda, Shetlands, have exceptionally small and narrow wings, with the ratio of their width to length of 20–22%. The female wing length is only 2.58 mm, which is smaller than any male measured.

Geomyza annae Martinek and *martineki* Drake (which is the *combinata* of Martinek (1978b) and Soós (1984)) are known from central Europe (Drake, 1992). These two species differ from *balachowskyi* and *hackmani* in having slightly broader wings and no shading at the end of vein M, but principally in their genitalia (Martinek, 1978b). The *combinata* of Mesnil (1934) has similar genitalia and wings to those of *hackmani* but has a long anepimeral seta like that of *tripunctata*; no-one seems to have confirmed that such a fly exists.

This species is widespread and moderately frequent in Britain and records extend northwards to the Highlands. No habitat preferences are discernible in the records.

Assuming that Nye (1958, 1959) was dealing with *balachowskyi*, he reared it from *Lolium perenne* L., *Arrhenatherum elatius* (L.) Beauv. ex J. & C. Presl, *Holcus* species, wheat and barley. He cast doubt on the records of *G. combinata* larvae given by Frew (1923) and suggested that they were probably *G. tripunctata*. Nye found that the larvae overwinter in basal tillers, pupariate in April and emerge in May; they probably have a second generation in July. However, dates of capture of adults (not separated from *G. hackmani*) range evenly from the end of June to mid October.

Geomyza breviseta Czerny, 1928. This and *G. subnigra* are the two British species that always have dark thoraxes. Many specimens of *G. tripunctata* are dark but their wing pattern makes them amply distinct. *Geomyza breviseta* closely resembles *G. subnigra* but may be differentiated by its more chestnut-coloured thorax which also has more pronounced metallic reflections on its paler parts, and in having less contrast between the dusting on the thorax and abdomen. The apparently slight difference in the shading of the costal cell beyond vein h does seem to be distinct. However, all these characters are somewhat comparative and should not be relied upon to identify isolated females unless the ovipositor is closely examined by slide-mounting or viewing in alcohol; sternite 8 is apically emarginate in *breviseta* (Fig. 5f) but produced to a narrow, faint point in *subnigra* (Fig. 5e). Males are easily distinguished by the genitalia even if these are not exerted because the cerci are very small in *breviseta* but in *subnigra* are similarly proportioned to those of *tripunctata*. The dimensions of the wings and thorax are virtually the same in both species; the differences in Fig. 1 are due to the specimens that were drawn being different sexes.

Three other European species have dark thoraxes, so superficially resemble *breviseta* (and *subnigra*). *Geomyza paganettii* Strobl and *G. denigrata* Czerny have broad wings whose widths are about 34% of their lengths, and *paganettii* has four dorsocentral

setae. *Geomyza denigrata* and *G. adusta* Loew have only vaguely darkened wing tips and neither crossvein darkened.

Genuine specimens of *brevisetia* seen by me come from Kent (Folkestone), Wiltshire (Coombe Bissett), Cambridgeshire (Barnack Hills and Holes NNR) and South Yorkshire (Pieces Bank). The species has been pooted from tussocks of *Poa trivialis* L. on limestone grassland which was lightly grazed by sheep, swept from moderately tall, slightly calcareous grassland and caught in pitfall traps set in ungrazed chalk grassland. Based on this evidence, it may be restricted to calcareous grassland.

Geomyza hackmani Nartshuk, 1984. Vockeroth (1961) and Chandler (1991) have pointed out that there is a second species of "*combinata*" here besides *balachowskyi* though Nartshuk's name and description of the second type appear to have been overlooked. Separation from *balachowskyi* can be made reliably only on the basis of the male genitalia. The ground colour of the postnotum in the eleven males seen by me is conspicuously darker than the rest of the thoracic dorsum although it is quite heavily grey-dusted. Until a much larger sample is checked, it would not be wise to use this character by itself or to assume that females may be identified using it. Because of the confusion, *hackmani* has probably been overlooked but it seems to be genuinely uncommon. It has been found in grasslands on alluvium, limestone, neutral clay and on freshwater and slightly brackish coastal grazing marshes. There are records from Surrey, Oxfordshire (Vockeroth, 1961), Greater London, Cambridgeshire, Worcestershire, Gwent, Cumbria and Aberdeenshire. Dates of capture range from early July to early September.

Geomyza hendeli Czerny, 1928. Czerny described this species from one female with its legs missing. Hackman (1958) concluded that it was just a small form of *apicalis*, because the wing pattern and shape were the same in both species and *apicalis* sometimes lacks the small postsutural dorsocentral seta and so resembles *hendeli*. Martinek (1978a) considered *hendeli* to be a good species, but a male and two females that Dr Martinek lent to me look very much like *apicalis*. These have very small postsutural dorsocentral setae although they are still discernible. *Geomyza hendeli* was added to the British list on the basis of a male (in the Natural History Museum) identified by Collin (1945). Its genitalia are identical to those of *apicalis*, its thorax is 0.98 mm long, its wing is 2.13 mm long and the wing's breadth is 20% of the length; these dimensions are well within the range of variation of *apicalis* (Table 1). I consider this specimen to be a not particularly small specimen of *apicalis*. Two other specimens labelled *hendeli* in the Natural History Museum are typical *apicalis*, one having a small postsutural dorsocentral seta on one side and genitalia that are indistinguishable from those of *apicalis*. Two females, from Wicken Fen, Cambridgeshire (I. Perry) and Dungeness, Kent (R. K. Morris), completely lack a small postsutural dorsocentral seta. They closely resemble *apicalis*, but features which may be trivial, that are found only in extreme examples of *apicalis*, are the dark brown occiput which is usually paler or patchy brown in *apicalis*, clearly defined dark notopleurae which are often only indistinctly brown in *apicalis*, and, on the dorsum of tergites 2–4, conspicuous marginal setae which are often not clearly larger than other setae in *apicalis*. I have not seen another specimen ascribed to *hendeli* from Holme, Norfolk (1983) collected from dunes which are frequently the habitat of *apicalis*. Thus, although the identity of *hendeli* is far from satisfactory, it would be prudent to retain the name for specimens that completely lack a small postsutural dorsocentral seta until a series of males can be compared with *apicalis*.

Geomyza majuscula (Loew, 1864). This species looks like a large *tripunctata* and for the small sample of *majuscula* that were measured, its wing and body dimensions fall just beyond the range of values for *tripunctata*. Apart from its larger size, *majuscula* may be tentatively separated from *tripunctata* in the field by the absence of the basal wing spot which is usually very distinct in live *tripunctata*. The thorax is usually orange. *Geomyza brevisetis* Hackman appears to be identical to *majuscula* and is most probably a junior synonym, as Hackman (1958) himself suggested.

Geomyza majuscula has been recorded from Hampshire (Chandler, 1991), Suffolk, Norfolk, Cambridgeshire, Dyfed, Cumbria and the Highlands. Most of the localities are rich fens or pond or river margins (one with *Carex*, another with *Phalaris arundinacea* L.). Capture dates range from March to October. It is classified as nationally scarce (Falk, 1991).

Geomyza subnigra Drake 1992. This is a moderately uncommon species in Britain and has been confused with the scarcer *brevisetis* although some records of *brevisetis* may genuinely refer to this species. It runs to either *brevisetis* or *hendeli* in the keys of Collin and Czerny, depending on how well differentiated the longest subvibrissal bristle is. Its separation from *brevisetis* is discussed under that species.

The known habitats are predominantly dry, e.g. chalk grassland and scrub, coastal dunes, coastal shingle, and suburban grassland. Wetter habitats included a Scottish birch wood. Audcent (1950) recorded it from *Bromus* sp. but it is more often associated with *Arrhenatherum elatius*. It has a life history unusual for the genus, adults occurring throughout the year; Ismay (1974) recorded it (as *brevisetis*) at the roots of tussocks of *A. elatius* throughout a complete year though it was most abundant in autumn and winter, and a pair *in cop.* (in the Natural History Museum) was caught in mid February. Where the collecting method was known, it was usually tussocking or pitfalling but rarely sweeping. It has been observed running and jumping among the deeper layers of tall dune grassland. Although Falk (1991) considered it to be nationally scarce, its secretive behaviour is almost certainly the reason for the few records and is likely to prove widespread.

As there are many more verified records (*) of *subnigra* than of *brevisetis*, the former is assumed to be the more frequent of the pair. Therefore, all unchecked records of "*brevisetis*" are included here, though doubtless some have been correctly named by chance: Kent, East Sussex*, Greater London, Surrey*, Hampshire*, Avon, Wiltshire*, Dorset, Oxfordshire, Essex, Suffolk, Norfolk*, Cambridgeshire*, Worcestershire*, Dyfed*, Gwynedd, South Yorkshire, Northumberland* and Highland* (Allen, 1967, 1977; Parmenter, 1960; Collin, 1945; Ismay, 1974).

Geomyza tripunctata Fallén, 1823. The only other species of *Geomyza* with the bold wing pattern of *tripunctata* is *majuscula*, which lacks the long anepimeral seta and basal wing spot. The colour of the thorax is variable and, although usually blackish, it may be clear orange as it is in most specimens of *majuscula*.

Mesnil's *combinata* also possesses a long anepimeral seta, but the identity of this species is uncertain because the description of the wing in Mesnil (1934) does not tally with the figure that looks remarkably like *tripunctata* in Balachowsky & Mesnil (1935).

Geomyza tripunctata is the commonest species of the genus, widespread throughout Britain and found in almost all grassy habitats. It may be found from March to November, with a distinct peak in abundance in April and a less clearly defined one in later summer. Thomas (1938) concluded that it had two generations each year. Larvae have been recorded feeding on a number of common grasses but most often

on *Lolium* species (Thomas, 1938; Nye, 1959). After feeding in the central shoot of the grass stem, the larvae pupariate within it, overwintering mainly in the third (final) instar. This is a pest species of ley, and the numbers of larvae may be markedly higher in well fertilized leys than in those receiving low inputs of nutrients (Moore & Clements, 1984). The larvae are parasitized by the braconids *Chasmodon apterus* Nees and *Phaenocarpa livida* Haliday and the pteromalid *Stenomalinus* sp (Thomas, 1938; Moore *et al.*, 1986).

Geomyza venusta (Meigen, 1830). This species superficially resembles *balachowskyi* and *hackmani* in body colour and wing size but differs from them in crossvein r-m being entirely pale, the wings being markedly broader (the width 27–33% of the length), the thorax noticeably shiny and with brown marks outside of the postsutural dorsocentral setae and a reddish or brownish tinge on the notopleura, and the postnotum often being black, at least centrally. The male genitalia are distinctive but the European species *G. annae* Martinek has similarly bilobed apices to the surstylar lobes (Martinek, 1978b). That species has a small spot on the r-m crossvein like *balachowskyi*.

Although *G. venusta* has been infrequently recorded in Britain and Falk (1991) classified it as nationally scarce, on the Continent it is a fairly common and widespread though minor pest (Balachowsky & Mesnil, 1935, Soós, 1984). Its larvae have been recorded from *Bromus* and they overwinter within the shoots (Balachowsky & Mesnil, 1935). Most of its British localities are chalk grasslands and it can be frequent in this habitat (L. Clemons, pers. comm.; Allen, 1982). There are records from Kent, East Sussex, Surrey, Hampshire, Hertfordshire, Buckinghamshire, Oxfordshire, Cambridgeshire, Salop, Strathclyde and Grampian. Its flight period is from early June to late August, with most records in July.

ACKNOWLEDGEMENTS

I am grateful to Dr Stuart Ball, Dr Bill Ely, Steven Falk, David Gibbs, Dr Tony Irwin (Castle Museum, Norwich), Dr John Ismay, Dr Ian McLean, Roger Morris, Ivan Perry, Del Smith and the Trustees of the London Natural History Museum for the loan of specimens and for submitting records, and especially to Dr Vladimir Martinek for the loan of several *Geomyza* from central Europe.

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BOOK REVIEW AND NOTICES

Principles of acarology by G. O. Evans, CAB International, Wallingford, xviii + 564 pages, £65, hardback.—The ticks and mites are almost as diverse as insects in their habits and lifestyles, being terrestrial, aquatic (salt and fresh water), herbivores (including gall-makers), predators, commensals and parasites. This astonishing variety is excellently presented in this formidable textbook. The book concentrates on the functional morphology of the Acari, constantly comparing and contrasting structure and function across the many different modes of life. The largest chapter is on classification, detailing the many different groups of ticks and also the relationship between the ticks and other arthropods. Mites and ticks are an order of magnitude smaller than insects—for example the holothyrids which are regarded as ‘large to very large’ have adults ranging from 2 to 7 mm! Nevertheless, many species are of major economic or medical importance—*Varroa* on honeybees, Lyme disease transmitted by ticks, spider mites on garden plants and crops, chiggers etc—and many have developed intimate relations with insects and other animals. All aspects of the creatures’ biology are considered, profusely illustrated and thoroughly referenced.

R. A. JONES

Insect pollination of crops, 2nd edn by John B. Free, London, Academic Press, 1993, xii + 684 pages, hardback.—After a general introduction to pollinating insects—mainly honeybees, bumblebees and solitary bees—there follows an extensive review of pollination, arranged by plant crop family.

The larvae of gall midges (Diptera: Cecidomyiidae) by B. M. Mamaev and N. P. Kirvosheina, translated by J. H. Wieffering, edited by J. C. Roskam, Rotterdam, Balkema, 1993, x + 294 pages, £30, hardback.—This is a translation of the original Russian work *Lichinki gallits*, published in Moscow in 1965. After introductory chapters on biology, comparative morphology, collecting, preservation and study, the major portion of the book is devoted to a systematic outline of gall midge larvae.